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On Stellar Evolution in a Neutrino Hertzsprung–Russell Diagram

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We explore the evolution of a select grid of solar metallicity stellar models from their pre-main sequence phase to near their final fates in a neutrino Hertzsprung-Russell diagram, where the neutrino luminosity replaces the traditional photon luminosity. Using a calibrated MESA solar model for the solar neutrino luminosity ($L_{\nu,\odot}$ = $0.02398 \cdot L_{\gamma,\odot}$ = 9.1795×10^{31} erg s^{-1}) as a normalization, we identify $\simeq$0.3 MeV electron neutrino emission from helium burning during the helium flash (peak $L_\nu/L_{\nu,\odot} \simeq 10^4$, flux $\Phi_{\nu,\mathrm{He\ flash}} \simeq 170$ (10 pc/d)^2 cm^{-2} s^{-1} for a star located at a distance of d parsec, timescale $\simeq$ 3 days) and the thermal pulse (peak $L_\nu/L_{\nu,\odot} \simeq 10^9$, flux $\Phi_{\nu,\mathrm{TP}} \simeq 1.7{\times}10^7$ (10 pc/d)^2 cm^{-2} s^{-1}, timescale $\simeq$ {0.1 yr) phases of evolution in low mass stars as potential probes for stellar neutrino astronomy. We also delineate the contribution of neutrinos from nuclear reactions and thermal processes to the total neutrino loss along the stellar tracks in a neutrino Hertzsprung-Russell diagram.
We find, broadly but with exceptions, that neutrinos from nuclear reactions dominate whenever hydrogen and helium burn, and that neutrinos from thermal processes dominate otherwise.

Collaboration name

Primary author: FARAG, Ebraheem (Arizona State University)

Co-authors: Prof. TIMMES, F.X. (Arizona State University); TAYLOR, Morgan (Arizona State University); PATTON, Kelly (Department of Physics and Astronomy, Colby College); FARMER, Robert (Anton Pannenkoek Institute for Astronomy and GRAPPA, University of Amsterdam)

Presenter: FARAG, Ebraheem (Arizona State University)

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